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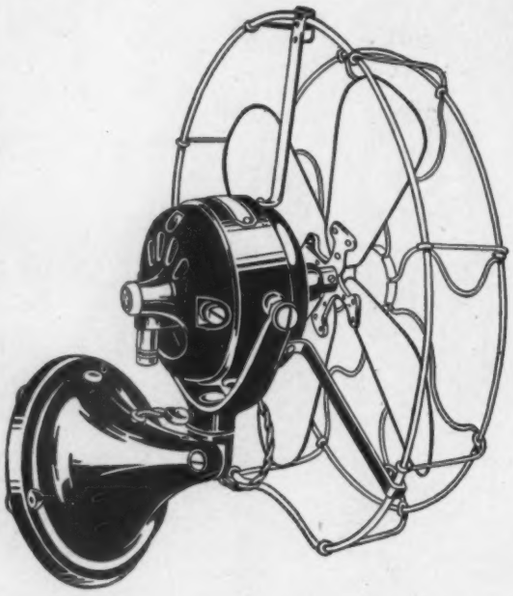

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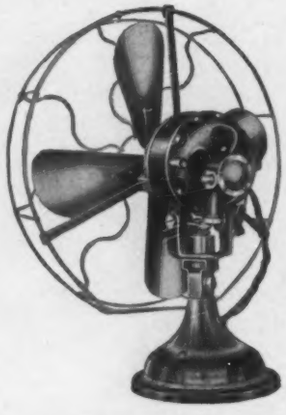

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HIGH VOLTAGE POTENTIOMETERS

BY HARRIS J. RYAN.

(This paper forms a most important contribution to the study of sporadic insulator troubles. It illustrates and describes the use of the condenser potentiometer in measuring the voltage duty of suspension type insulators. Details are given of many integrity trials, together with checks by means of the transformer potentiometer, whereby the potential of an accessible surface of an insulator can be determined with an error not to exceed three or four per cent. This wonderful apparatus was developed by Prof. Ryan in the high tension laboratory at Stanford University.—The Editor.)

The successful application of high voltages has been made possible only by the use of insulators built up of parts. Such parts must have a proper mutual relation as to make-up and mounting. Their correlation is correct and satisfactory only when each part is made to carry no more than its fair share of the aggregate voltage duty. The modern high voltage transformer insulations, bushings and suspension line insulators are examples of important segmented insulators. There is no line of electrical work in which one should be better prepared to calculate proportions or to check one's calculations or efforts of judgment by actual measurements. And yet here is where calculations and measurements are most difficult and, as a consequence, progress in rational design has been correspondingly slow. This is due largely to the fact that everything is permeable to the electric field; conductors infinitely so, and all other bodies, the dielectrics, to much the same extent among themselves, their electric inductive capacities ranging, for the most part, from 1 to 6 or more times that of air. There are never definite, well defined routes of electrostatic flux. Such routes, or tubes of flux, are everywhere expanding or contracting—quite different from the flux of current in the electric circuit wherein most things can be so easily calculated. The problem of proportion in insulation is, therefore, very much like similar problems that occur in those divisions of pneumatics and hydraulics that have to deal with the flow of loosely confined fluids. In such turbulent problems systematic measurements must always make up for the lack of reliable calculations. The present article is a contribution to the subject of the measurement of the voltage duties sustained by the several links of an insulator chain that supports the aggregate strain of a given high voltage stress.

Condenser Potentiometer.

In a satisfactory high voltage potentiometer the potential selector must provide an adjustable alternating potential having the same phase and wave form as the alternating potential to be determined. The former is the known and the latter the unknown potential. The "zero" or potential balance indicator must do its work without disturbing the value of the unknown potential. As a whole, the instrument must be inherently inexpensive, otherwise it can have but a limited use. All high voltage study tends to be expensive; it is extravagant of required space and rather poverty stricken in experimental expediency. Accordingly a "multiple-tap" or series air-core condenser is connected across the high voltage source and used as the potential selector. From this any desired potential is selected and applied through a flexible conductor to a piece of metal mounted on the part of the insulator whose potential is to be determined. This flexible conductor terminates in a pointed conductor or needle and is carried on an insulating rod wherewith it may be manipulated safely by hand. The pointed conductor or needle is called the probe and the flexible connecting conductor is called the probe cable. The probe is manipulated by hand so that one can see when the known and unknown potentials are balanced.

Advantage is here taken of the fact that when two condensers, charged to different potentials, are thrown in multiple there will always be a flash, big or little, where the last contact is made, due to the passage of a high frequency current. This flash never fails even when the capacities and potential differences are small. In the dark, therefore, one can easily see when the potentials of two condensers are quite exactly alike because they can be thrown together with a "scratching contact" and without producing a visible spark. We are all familiar with the spark produced on shorting the terminals of a telephone condenser charged to a few volts only.

The whole arrangement is simple, inexpensive, easily understood and applied. Fig. 1 is a picture of the first of these potentiometers set up for use in the field to determine the voltage duty of the sections of suspension insulators when dry, compared with their corresponding duties when covered with wet dust,

cement and smoke or with rain.* The reader will have no difficulty in understanding the structural details as they are all told in this photograph. The condenser was made by stacking 31 common tinned sheets, 30x30 inches, using ordinary porcelain cleats as separators. When connected across the source voltage this made a 30 step potential selector. With it the potential of any part of an insulator, subjected to the source

Fig. 1. High Voltage Condenser Potentiometer in Field Test Set Equipment; used in the dark in shack back of men in picture.

voltage, could be matched directly to a thirtieth of the total voltage. By watching the strength of the "out of balance" spark at the probe one could split these units and make potential settings true to about a sixtieth of the total voltage.

There are three sources of error in the use of this high voltage potentiometer:

1. The spread of the electric field through the potential selector stack.

2. The disturbance of the normal voltage duty of the test specimen by the presence of the probe and the probe cable.

3. The capacity of the probe cable diverting electric charge from the plates of the potential selector, thus changing their potentials which should otherwise be proportional to the elevation they occupy in the selector stack.

The first error due to the inevitable spread of the electric field must be reduced to a point whereat it is negligible by the old expedient of guards from which are supplied the "leakage field" and by making the height of the stack only a third of the length of the shorter sides of the sheets. In Fig. 1 the stack appears taller than this. Here the high voltage source consisted of three 37.5 k.v. transformers connected in series. Thus was provided one terminal grounded and three high voltage taps at intervals of 37.5 kilovolts, the three supplying 112.5 kilovolts. These four terminals were connected correspondingly to the first, eleventh, twenty-first and thirty-first plates in the selector. In such manner the stack was divided into three sections, each of which had its own spread of electric field set up largely from its own guards mounted at each tapping-in plate and as may be seen in Fig. 1. Thus the proportions in this case were made to conform to the rule given above.

The second error due to the disturbance in the electric field in and about the insulator produced by the approach of the probe and probe cable is easily eliminated. The probe should enter the field of the insulator as nearly at right angles to its average direction as, under one's judgment, this may be done. As much of the probe cable as is practicable should be mounted in a neutral position with respect to the leads from the high voltage source. This fixes the capacity effect of the probe cable. The probe cable is then connected to that plate in the distributor which, in one's judgment, carries a potential near to that of the test specimen. The probe point is applied to the test specimen to note the degree of difference, indicated by sparks, that may remain between the known and unknown potentials. The probe is withdrawn, the cable is connected to a plate of higher or lower potential, the probe is reapplied and the extent of the potential difference is again noted. By this procedure may be observed the zone of known potentials through which the unknown potential develops a more or less even degree of approximate balance. This zone sometimes is very narrow, in fact it will have no appreciable width when the probe produces little or no disturbance in the field of the test specimen. It may have a potential width amounting to several selector units if the probe is causing considerable disturbance. Through this zone lack of balance is appreciable everywhere to about the same extent, as shown by the strength of the probing spark. The borders of the zone are always sharply defined by the reappearance of a definite strong spark due to unbalancing as the probing potential is further elevated or depressed. If the zone is quite narrow its upper and lower limits will correspond and there will be a sharp definite balance. Often one finds a particular potential tap whereat there is no visible spark when the probe point is scratched over the metal on the test specimen. It has been found by experiment that the known upper and lower potentials that limit this balancing zone are symmetrically placed with respect to the true value of the unknown potential. The error due to the disturbance caused by the probe is eliminated, therefore, by recording the mean of such upper and lower potentials as the true value of the potential of the test specimen.

The third error, due to the inevitable capacity of the probe and its connecting cable, must be eliminated by calibration or calculation. Fortunately the capacity of such a conductor as this probe cable with respect to other objects when ordinarily remote, changes but slightly. An ordinarily remote distance here may be taken as 100 or more diameters of the probe cable. It is important that the calculation of the correction for this error be maintained as simple as possible. Accordingly the probe cable throughout the greater part of its length should be mounted so as to be exposed only to lower potentials of any electric fields set up by the leads from the source voltage, etc. The effect of the capacity of the probe cable to the source leads, etc., may then be

*Sporadic Insulator Troubles by Harris J. Ryan. Journal of Electricity, Power & Gas. Vol. XXXIV, p. 162, Feb. 27, 1915.

neglected and the only capacity to be dealt with is that of the probe cable to the earth and nearly neutral bodies. Such capacity varies but little under the changes in position of its end sections that must occur in its ordinary use, with a correspondingly small effect in the value of the resulting correction. Even when the over-all capacity of the potential distributor is no larger than the capacity of the probe cable, the value of the latter capacity may easily be estimated with sufficient accuracy to make the corrected result come within the limits of accuracy set by other factors that

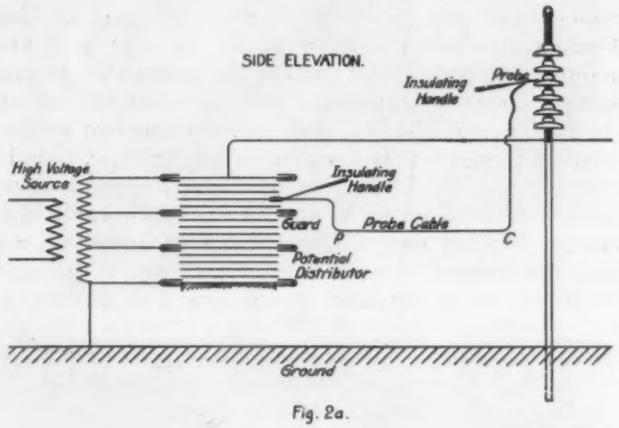

Fig. 2a.

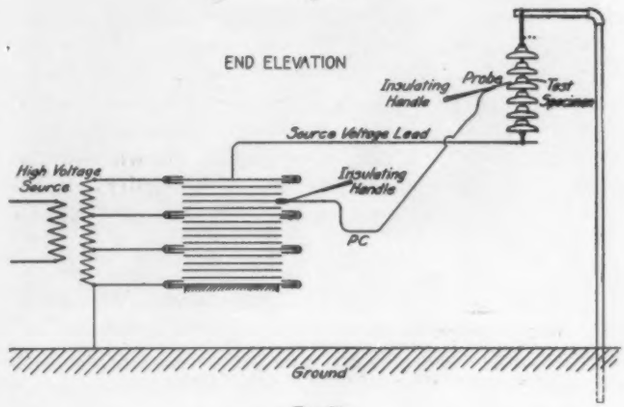

Fig. 2b.

Fig. 2. Potentiometer Set Up for Determination of Voltage Duty of Suspension Insulator Units.

are inherent in this general class of high voltage measurements. Calibration in lieu of calculation for the elimination of this error will be dealt with later in connection with the integrity trials.

The general arrangement of the potentiometer when set up for the determination of the voltage duty of the units in a suspension insulator is given for side and end elevations in Fig. 2. Note that the major portion of the probe cable pc is mounted in a region of low potential, excepting, of course, the potential of the probe cable itself, due to its connection to the potential distributor. The corresponding electrostatic scheme is given in the diagram of Fig. 3.

There are N equal potential sections in the distributor and the probe is connected to the nth section, counting the end section next to ground potential as 1. The capacity of a single section is C_o, and the capacity of the probe cable to ground is that of its equivalent condenser, C_p, assumed to be connected from the probe cable to ground. As a practical matter C_p can be considered as constant for all positions of the probe and distributor ends of the probe cable. This has been found to be true in a number of integrity trials. Being connected in multiple with the n-sections of the potential distributor, C_p acts in a definite manner to lower the total potential delivered by such n-sections to the probe cable and probe. The relation between the source voltage (e), the number of sections connected to the probe (n), and the probing potential (V_n) may, therefore, be derived and expressed algebraically thus:

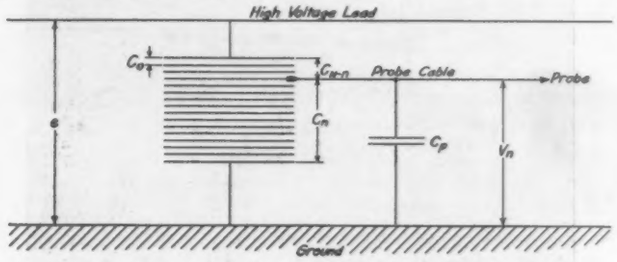

Fig. 3.

Fig. 3. Electrostatic Scheme for Determination of Voltage Duty.

$$V_n = \frac{e}{(N-n)\left(\frac{1}{n} + \frac{C_p}{C_o}\right) + 1} \qquad (1)$$

e = Applied source voltage.

V_n = Potential voltage identified by probe.

N = Number of potential sectors in voltage distributor.

n = Number of potential sectors connected to probe cable.

C_o = Capacity of single potential condenser-sector.

C_p = Capacity of probe cable to earth.

If there were no correction for the capacity of the probe cable the value of C_p would be zero and the above equation No. 1 would become.

$$V_n' = \frac{ne}{N} \qquad (2)$$

The amount of the error due to probe cable capacity is found, by subtracting (2) from (1) and reducing, to be

$$V_n' - V_n = e\left(\frac{n}{N} - \frac{1}{(N-n)\frac{C_p}{C_o}}\right) \qquad (3)$$

From this it is seen that the error increases as the number of potential sections, (n), and in the manner here given. With some experience in these matters the value of C_p can always be calculated from the related dimensions with sufficient accuracy, even when C_p is as large or a little larger than the aggregate capacity of the distributor $\frac{C_o}{N}$. Without some trained judgment in regard hereto it is best to make the distributor capacity $\frac{C_o}{N}$ as much as three times as large as C_p, thus:

$$\frac{C_o}{N} = 3\,C_p \qquad (4)$$

This may be accomplished by using as short a probe cable as practicable, and then increasing the area of the potential distributor plates until the relation in equation (4) is approximately attained. Ordinarily convenient proportions, such as used in the experiments here reported, make C_p and $\frac{C_o}{N}$ nearly equal.

Fig. 4. Integrity Trial of Condenser Potentiometer Using a Uniform Electric Field Set Up Between Large Parallel Plates and Guards and a Circular Ten-Inch Metal Disc as a Probing Electrode.

Results.

Potential kilovoltage of probing electrode due to position.	Potentiometer Corrected for probe cable capacity.	Kilovoltage Uncorrected for probe cable capacity.
130	130	130
114	114	124
100	105	114
83	83	88
69	69	69
51	54	51
35	33	26
18	15	8
0	0	0

Condenser Stack Data: Size of plates 36 by 36 in.; thickness, .023 in. Pitch, .84 in. No. of plates, 49. No. voltage sections, total 48; to neutral, N = 24. Capacity per section C_o, calculated, .00035 m.f. Capacity of probe cable, C_p; Length, 8 ft.; effective diameter due to conductor, rubber insulation and braiding, assumed equal to that of No. 0 B. & S. G.; used at an average height above ground of 7 feet. Capacity calculated, $C_p = .000018$ m.f.

Capacity ratio for use in correction formula:

$$\frac{C_p}{C_o} = .0517$$

This theory for the instrument was not worked out by a priori reasoning. It was developed at the close of a series of experiments and integrity trials that were begun in March, 1912, and concluded in 1913. The method generally adopted for such integrity trials was that in which a suitable probing electrode was insulated and so placed in an electric field that its potential due to its position could be correctly calculated. This can be accomplished conveniently in three forms of electric fields:

1. The uniform field set up between parallel electrode plates (see Fig. 4). The proper form of probing electrode in this case is a metal disc insulated and mounted at right angles to the field, so as to be in a known potential plane.

2. The variable field set up between two similar electrode cylinders mounted parallel (see Fig. 5). In this form of field the potential values are everywhere known and the potential surfaces are cylinders. The central axis of such surfaces differ in position by a well-understood law. The probing electrode may, therefore, be an insulated wire mounted parallel to the electrodes at any point in the field or it may be a circle of wire or strap of metal of any diameter insulated and mounted in a plane at right angles to the electrode cylinders and coincident with the equipotential cylinder of corresponding diameter.

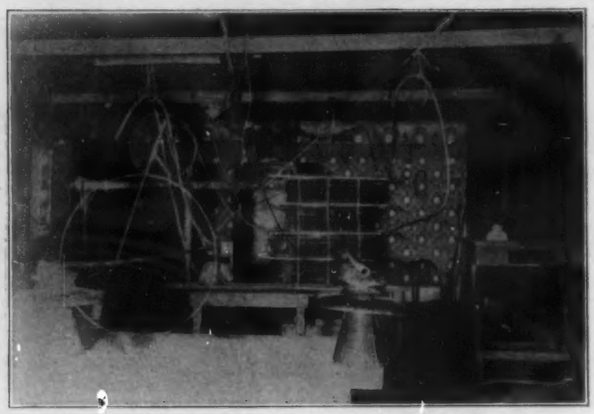

Fig. 5. Integrity Trial of Condenser Potentiometer, Using Electric Field Set Up Between Two Parallel Conductors and Rings of ¼-Inch Soft Copper Tubing as Probing Electrodes.

Results.

Potential Voltage of probing electrodes due to their positions.	Potentiometer Voltage. Corrected for probe cable capacity.	Uncorrected for probe cable capacity.
24.4	24	14
33.2	34	26
41.7	42	37
46.6	48	45

Condenser stack and probe cable constants same as in preceding case.

3. The radial field set up between two concentric electrode cylinders (see Fig. 6). In this case the field diminishes uniformly with increase of radial distance from the inner electrode. Here all potential surfaces are again cylinders, having in this case axes that coincide with those of the electrodes. The probing electrode may, therefore, be a wire or a circular hoop as in the preceding case.

An integrity trial for the potentiometer consisted, therefore, in setting up for such purpose one of these three fields. In it the probing electrode was insu-

lated and mounted in a known position, and its potential determined by probing for a balance in the potentiometer. The result corrected or uncorrected was compared with the actual potential of the probing

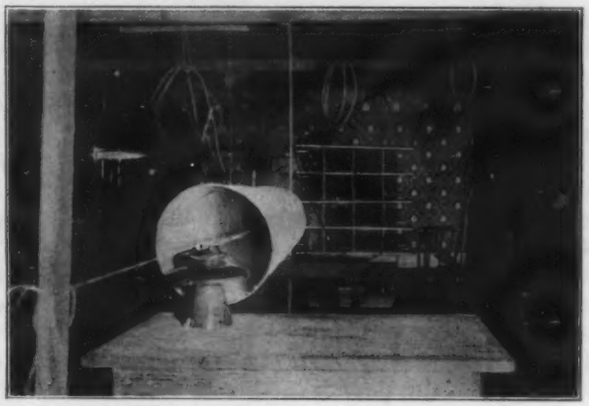

Fig. 6. Integrity Trial of Condenser Potentiometer, Using Electric Field Set Up Between Concentric Cylinders and a Piano Wire as a Probing Electrode.

Results.

Potential Voltage of probing electrodes due to their positions.	Potentiometer Voltage. Corrected for probe cable capacity.	Uncorrected for probe cable capacity.
20.0	19.5	12.5
28.5	31.	26.
35.5	39.	37.
44.5	45.	45.

Condenser stack and probe cable constants same as in preceding case.

electrode calculated from its position in the field. Typical results of this class are given in the titles of Figs. 4, 5, and 6.

Calibrations.—It is scarcely necessary to remark that any of the foregoing integrity trial methods may be adopted for calibration purposes, thus to avoid the necessity of calculating the error due to the capacity of the probe cable.

Transformer Potentiometer.

In order to be absolutely certain that a thin conductor when mounted in a potential surface of an electric field will take up and manifest the actual potential of such surface, an independent check in regard hereto was instituted. For this purpose the condenser potential distributor was replaced by a high voltage transformer having a primary low voltage supply taken through an independent voltage regulator. This is called the probing voltage, to distinguish it from the main high voltage which must remain fixed in value during any of these integrity trials. Although the main and probing high voltage transformers are supplied from the same single phase source, they will inevitably differ somewhat in phase relation as the probing voltage is raised or lowered, and this prevents the comparison of the alternating potentials and voltages by means of a probe. To show a balance at the probe they must have the same phase and wave form and be equal in amount.

To establish "in-phaseness" for the main and probing voltages both transformers are supplied from the same approximate sine-wave polyphase current source. The main voltage transformer is supplied from one of the phases while the probing voltage transformer is supplied from the secondary of an induction phase-changing transformer having its primary connected to all phases of the source. The phase of the probing voltage is then shifted when necessary so as to maintain it at all times exactly in phase with the main voltage. There remains some manipulating difficulty due to the fact that in these circumstances the main and probing voltages are bound to differ a little in wave form so that the balance shown at the probe point is never so clearly defined as when the condenser potential distributor is used as a source of variable voltage. However, with some care and a little patience it was found that the variable phase-voltage transformer could be used as a definite power voltage to apply through the probe and to balance against the potential of an electrode mounted in an equipotential surface of an electric field to determine whether such electrode will accurately manifest the potential of such surface. The results obtained in this trial are given in Table I.

Table I.

No. of Plate in Condenser Stack.	Potential Voltage by Position. Kilovolts.	Potential by Variable Phase-Voltage Transformer Set. Kilovolts.
1	2.6	3.0
2	5.2	5.8
4	10.4	11.2
6	15.5	16.6
8	20.8	20.9
10	26.0	25.9
Neutral 12 grounded.	31.0	30.9
14	36.2	35.4
16	41.6	41.0

Total voltage applied to stack of 25 plates and 24 sections, 62 kilovolts. Ratios of transformation and voltage wave forms assumed constant. No effort in regard thereto was made for refinement nor with regard to the accurate mechanical forming up of the condenser stack. Top and bottom plates in the condenser stack were numbered 0 and 24. Plate No. 12 and the neutral of the source being grounded it was not considered necessary to locate with the transformer-potentiometer the potentials of all of the lower half of the stack.

They show that an electrode plate does take up the potential, due to the position that it occupies in an electric field. However, the work that preceded this to determine the integrity of the condenser potentiometer as such, established much more definitely though less directly, that the probing electrode will take up the true potential in the electric field, due to its position.

Incidentally the foregoing integrity trial demonstrated the reliability of the variable voltage-phase transformer set and probe as a high voltage potentiometer. It has been called the transformer potentiometer. Though more cumbersome than the condenser potentiometer, it has no probe-cable capacity correction, an advantage that in many circumstances will offset its disadvantages encountered, because of the difference in the wave forms of the fixed high voltage applied to the test specimen and the variable voltage of the voltage-phase transformer set applied through the probe.

Conclusion.

It should be noted that the integrity trials, Figs 4, 5 and 6, were made in advance of a full knowledge of the nature of the corrections that must be made for the errors due to the capacity of the probe cable and the disturbance produced in the electric fields attached to a test specimen caused by the introduction of the probe. A study of the results of these trials lead to the theory, as given above, for the elimination of such errors by corrections. Our conclusion is that, with the aid of such theory, the potential of an accessible surface of an insulator can be determined by the means herein reported with an error ordinarily not exceeding from three to five per cent.

REGULATION OF PUBLIC UTILITY SECURITIES.

BY PAUL A. SINSHEIMER.

(After defining a public service corporation and the inspiration for its regulation, particular attention is given to the details of financial regulation. The treatment is broad-minded and the style interesting, abounding in epigrams. The paper is the summary of a talk given before the San Francisco Chapter of the American Institute of Bankers, Jan. 19, 1915. Mr. Sinsheimer is bond expert for the Railroad Commission of California.—The Editor.)

I find so often that there is a basic misconception as to the nature of a public utility enterprise that I propose at the beginning to indicate wherein the public service corporation is a distinct and special species. I take it that most of you here, by reason of your experience, are familiar with the sharp division between public utilities and ordinary commercial corporations. It is with you gentlemen a matter of every day business habit to regard a public utility in the light of its responsibilities and its obligations. You are always conscious of the peculiar legal status of the utility and you automatically measure any problem that relates to a utility in accordance with its legal environment.

The unthinking, and occasionally we find the unthinking man in both your business and mine, is prone to fail in an appreciation of the positive differences that prevail, separating the public utility into a special phase of our present day industrial life. These men have been known to censure harshly members of the State Railroad Commission for their assumption to accord a different treatment to public utility affairs than is granted in every day commercial life to the average industrial corporation. They are one with the railroad magnate who cursed the commission because God had created the ocean.

You gentlemen, connected as you are with banking institutions, work constantly in the realm of regulation. You do not resent this regulation. On the contrary you deem it wise. Such differences as may arise deal only with the administration of that regulation. Your banks are under public regulation, state and national, by reason of the fact that they are the depositaries of the funds of the people. In extending to the banks the privilege of receiving deposits, government assumes the responsibility of regulating their use of those deposits. To sum it up in a word, the regulation of your banks springs from a degree of public interest therein. And that is the identical inspiration of the regulation of public utilities—the degree of public interest therein.

The public's interest in the bank lies in the fact that the public money is in the keeping of the bank. The public interest in the utility lies in the fact that it is wholly dependent upon that utility for certain necessities of our present day civilized life. The distribution and sale of water is a public utility enterprise. The degree of public interest therein is vital. In lesser proportion, but nevertheless controlling, is the public interest in transportation by railroad or street railway, communication by telephone and telegraph, the service of gas and electricity for light and for fuel.

Out of our complex civilization has emerged the large corporate entity dedicated to the service of the public. As in the case of the banks, government has extended a privilege and assumes the responsibility of regulation.

This regulation divides naturally into three forms: the regulation of rates, the regulation of service, and the regulation of finances.

For the present purposes we shall be concerned primarily with the subject of regulation of finances.

It might well be asked, as it is now urgently asked in the congress of the United States, "Why should a state assume to regulate issues of securities of its public utility corporations?" The answer is plain. In order to regulate properly rates and service of these utilities, it is necessary to exercise a jurisdiction over their issue of securites, for, very obviously, a utility heavily overburdened with debt and under the necessity of devoting all of its revenues to the payment of interest upon that debt, can not and will not give to the public the degree of service which the public should demand. And it must be equally obvious that to pay interest upon an excessive indebtedness, the utility must collect from the public excessive rates.

You who are familiar with the public utility situation in San Francisco need not seek afar for a type of corporation overburdened with debt and unable, therefore, to render the service demanded. A high credit is a first essential to utility service. I have in mind also a utility corporation in the southern part of this state, which, through a peculiar alchemy of finance, permitted its shareholders to transfer their stock into bonds and has since been staggering under the burden it assumed.

The regulation of public utility securities is intended to grant a three-fold benefit: first, to the public; second, to the investor; and third, to the utility itself. The public is protected by an insurance that service shall not be impaired nor rates raised merely to pay interest on excessive debt. The investor is, of course, protected by a more careful safeguard of the securities which are issued. And the utility itself, that is, its shareholders, are benefitted by the pressure of an outward force to keep its debt down and its property intact.

In regulating public utility securities, the state assumes no direct obligation. Its authority is merely permissive. The proposal for the issue springs from the utility. The state, through its commission, merely passes judgment upon the application presented. The purposes for which securities may be issued are limited, but the corporation retains its freedom to contract indebtedness as it pleases.

The responsibility has not changed with regulation. It rests entirely with the utility. The spirit of the law contemplates that the commission shall give its authority under certain circumstances, even though it may believe the enterprise doomed to failure. While of course the commission will insist upon certain safeguards, it can not assume authority, nor a right, nor should it pretend to a superhuman wisdom to require absolute safety.

And I think it will not require much argument in these piping days of finance to persuade you that that much-hunted bird, absolute safety, like the juggerwasp, does not exist. Nor would it be a wise law that con-

templated that all investments should be free from doubt. Economic force is stronger than law, and such a law could only defeat itself. Therefore, I would issue a warning to investors and to the public that commission authority for the issue of securities under the California statute must not and cannot be accepted as a declaration of the commission's belief in the safety of those securities. There is reasonable restriction and there is insistence upon fair dealing, but it does not lie in the power and in the capacity of any man to say "This I pronounce good, and this I pronounce bad." Today there should be, by the investor and by the public, the same scrutiny of securities that was accorded in the past. Nor should they be beguiled into doing what otherwise they would not by the symbol "Approved by the Railroad Commission of California."

Securities have always been issued under the authority of the state. The corporation is a creature of the state. Today we only safeguard more closely the authority which the state previously gave more liberally.

This, I believe, though, and I think the bankers of the state uniformly agree with me—that regulation by commission has served to improve and to elevate the standard of the public utility securities of the state of California.

But if the state has no direct legal obligation toward the securities which it may approve, it has at least a duty toward the utility which it regulates. How unjust it would be to supervise our large public service corporations in all of their activities and then at random to turn them over to the mercies of every possible competitor. If the state regulates, so must it protect. And it is on this theory that there has grown up here and elsewhere a doctrine that would protect a utility in its field of operation so long as that utility records to the public a service as satisfactory, at rates as fair as any competitor could furnish.

Strangely enough, in our struggle to adjust our economic problems, we are pressing forward along two lines as directly opposed to the poles of the universe. Our states declare, through their various commissions, for utility protection—monopoly, if you please. Nationally, we declare for competition, and we invoke the penal provisions of the Sherman Act against the corporation which assumes to do aught that would stifle competition.

In California we have been given two striking examples of this contrary policy. You will recall that the Attorney-General of the United States attempted by suit, and, in fact, is now attempting by suit to dissolve the merger of the Central Pacific and the Southern Pacific. And you will recall in a decision affecting these two carries, the Railroad Commission of California declared against the severance of these lines, on the ground that it would impair the efficiency of what is now a strong and unified transportation system.

You may have observed also that it has been the policy of the Railroad Commission of California to permit the Pacific Telephone & Telegraph Company, in certain instances, to absorb smaller independent companies. This has been done in the interest of a vastly improved service and a correspondingly decreased rate. At the same time the national government, through the Department of Justice, has entered into an agreement with the American Telephone & Telegraph Company, the parent corporation of the Pacific Company, which would prevent such consolidations and contemplates a dissolution where consolidations have occurred. Certainly both policies cannot prevail. We have come to understand in America that economic force persists despite preventive legislation. Apparently, however, the understanding is not unanimous.

It is with such basis thought in mind as I have now outlined that a commission undertakes to pass upon public utility securities. And I shall sketch briefly some of the considerations which enter into its conclusions. But there is a primary consideration above all others, one that may not be acquired by rule or law. It is that same view point which enables one man to purchase a fruit crop from the blossoms on the trees; and another to purchase unerringly, the beef from the cattle on the hoof. It may be called intuition, or knack or horse sense. In importance it outranks all other considerations.

There has come to my notice recently the statements of two very practical and very efficient bond men who have summed up in a few words the essential tests for public utility investment. The first one covered the ground with these five topics:

(1) Earning power,
(2) Management,
(3) Physical condition,
(4) Location,
(5) Prospects.

The other gave a summary of six topics which I have abbreviated to this form:

(1) Earnings more than ample to pay interest or dividends.
(2) Assets equivalent for securities outstanding.
(3) Franchises extending beyond the maturity of the bonds.
(4) Diversity in revenue sources.
(5) A territory both growing and diversified.
(6) Safeguards for additional issues of the same security.

While these cover tersely the essential points, I have undertaken to group them differently and to add some elements that appear of importance.

The first standard is the physical one; that is, the plant. An inquiry into any security issue naturally goes to the nature of the business and to the type and condition of the operating system. The physical elements are fundamental.

A second standard is legal. At the very outset we are presented with the problems of the franchise; the mortgage, special agreements and contracts, and all that relates to taxation and investment status. Here, indeed, a volume might be written. The very subject of the franchise is so great that I shall not attempt to go into it, merely mentioning it and leaving it again. The subject of the mortgage is also of importance sufficient to warrant a special inquiry in itself. In any mortgage, however, I would direct your attention to two features; first, the percentage of additions and betterments against which bonds may be issued, and second, the earnings required as prerequisite to the issue of escrow bonds.

It is in the field of special agreements and contracts that we are apt to wander into uncertainties of corporate securities. Many a fair looking bond has been faulty at core, through subjection to a burdensome and inequitable contract. Some of you perhaps are familiar with certain water and power contracts of long standing, either so high or so low as to be dangerous on the one hand or onerous on the other.

The third standard is financial. I have chosen to divide the financial aspects of public utility securities into two divisions, the first representing the theme of valuation and the second concerning itself with earnings and expenditures.

There is perhaps no economic subject of present day importance more misunderstood than the subject of valuation. In 1898 the United States Supreme Court, in the celebrated case of Smyth v. Ames, laid down the rule that in fixing rates on public utility properties, the rate making body should allow a reasonable return upon the fair value of the property. And ever since that day, courts and commissions, public utility presidents and lawyers have been arguing and debating on the meaning of that phrase "fair value." And their theories vary from a belief that fair value means nothing, all the way to infinity and, I might say, back again.

One of the important duties devolving upon the California commission has necessitated a determination of the value of public utility properties. It is urged by some earnestly upon the commission that the value of a thing is not what it might have cost, but what it would have cost to get something else just as good. We have been told, for instance, that the value of Spring Valley is what it would cost to build Hetch Hetchy. And I suppose conversely it might with equal reason be argued that the value of Hetch Hetchy is what it cost to build Spring Valley.

Thus we have a fine cycle of reason which, like the jitney bus, starts where it pleases and terminates nowhere.

Again we have it urged upon us that fair value is determined by the earnings. And again we have the cycle that fair value determines earnings and that earning determines fair value.

The effort in finding value has been and must be to determine reasonable cost, and I think much of our trouble would be avoided if we held that fact in mind.

The fourth standard that I would suggest as applicable to public utility securities may be called the commercial standard. It relates to the market for the securities; to the value of the security as collateral for loans; to its convertibility and current price.

The fifth standard should be termed somewhat roughly the territorial. This, of course, relates to the nature of the territory served; the condition of monopoly or competition; the diversity of the territory, its growth and possibilities.

Finally, but by no means last in importance, is the sixth standard which I refer to as the managerial. This relates primarily to the type, efficiency and personnel of the management. It goes to the policy of that management; to its public relationship, to its general fitness. In the past too little heed I fear has been paid to the high importance of lofty and efficient managerial standards. There has been an effort to exploit rather than to develop. Here in our own city we have seen the type of public utility management evolve and change. The old day is passing and the new is dawning.

The public utility securities of California are passing into a new stage. They are passing into the third stage. The first period was a period of promotion. We have been passing through a period of development and we have now come to the third period of permanence. Each era served its special purpose. Those utilities which are now undergoing the process of financial reorganization should emerge upon a solid basis for future progress.

There is still more room in California for development, and any regulating commission that has the good of California in mind, as every commission must have, will recognize the necessity of a broad-minded and liberal attitude toward the issue of securities for these new projects. The public utility work of the state must be done and the people of the state should be, and I know are willing ungrudingly to pay an equitable price to have that work done.

The California commission has given its approval to $400,000,000 of new securities. It has a fixed policy to encourage the honest utility that undertakes to develop and not to exploit.

In conclusion let me place before you three lines of endeavor which have particularly marked the course of the California commission in its regulation of stocks and bonds.

First, proper provision for supplementary financing. The initial financing of California utilities was through the medium of bonds alone. The California commission has endeavored to work out a system of supplementary financing through the medium of a well fortified investment stock.

Second, an insistence upon the truthful balance sheet. There has grown up a practice among utilities of inflating their plant and property accounts by abnormal sums, in some cases in California running as high as $75,000,000. What would you think of a bank that listed, for instance, "rights and franchises" at $10,000,000? It is, of course, inconceivable. Still, today that is done by our utilities. The feature of all this that surprises me most is the utter indignation of some of our foremost utility proponents, when requested, to remove from their balance sheets these huge sums which represent nothing more tangible than the zephyrs of today and the rainbows of tomorrow.

Third, the elimination of illicit profits. The controlling interests of our California utilities, as elsewhere, have not uniformly come to the view that theirs is a trust and not a special privilege for profit. We have instances here in this state in which the controlling interest of the utility has sought, by diversion of funds, to sap the revenue of that utility for its personal benefit. These practices may take the form of a bold diversion of a million dollars or so, or they may take the more subtle shape of a highly inflated salary allowance or contract privilege. In the hurry and rush that its work imposes, the California commission is not able to accomplish in a day what it eventually hopes to do. These illicit profits have been curtailed, but there still remain many to be eliminated. In due time they will be eliminated.

INDUSTRIAL USES OF FUEL OIL

BY F. B. DUNN.

Oil Fired Metallurgical and Shop Furnaces.

[Continued.]

Fig. 74 illustrates a heat treating furnace which is used by many large manufacturers of machinery. This furnace is arranged with single and double compartments, the heating chambers being separated by a solid fire brick wall in such a manner that each chamber can be heated entirely independently of the other. At the side of the heating chamber is the combustion space, into which the burners fire. The heat passes from this space over a bridge wall and along the arch of the heating chamber. Circling this arch, the heat is drawn across the hearth and into the flues, which criss-cross under the hearth, thereby heating the floor of the furnace from above and below, and saving some of the waste heat that would otherwise have been lost.

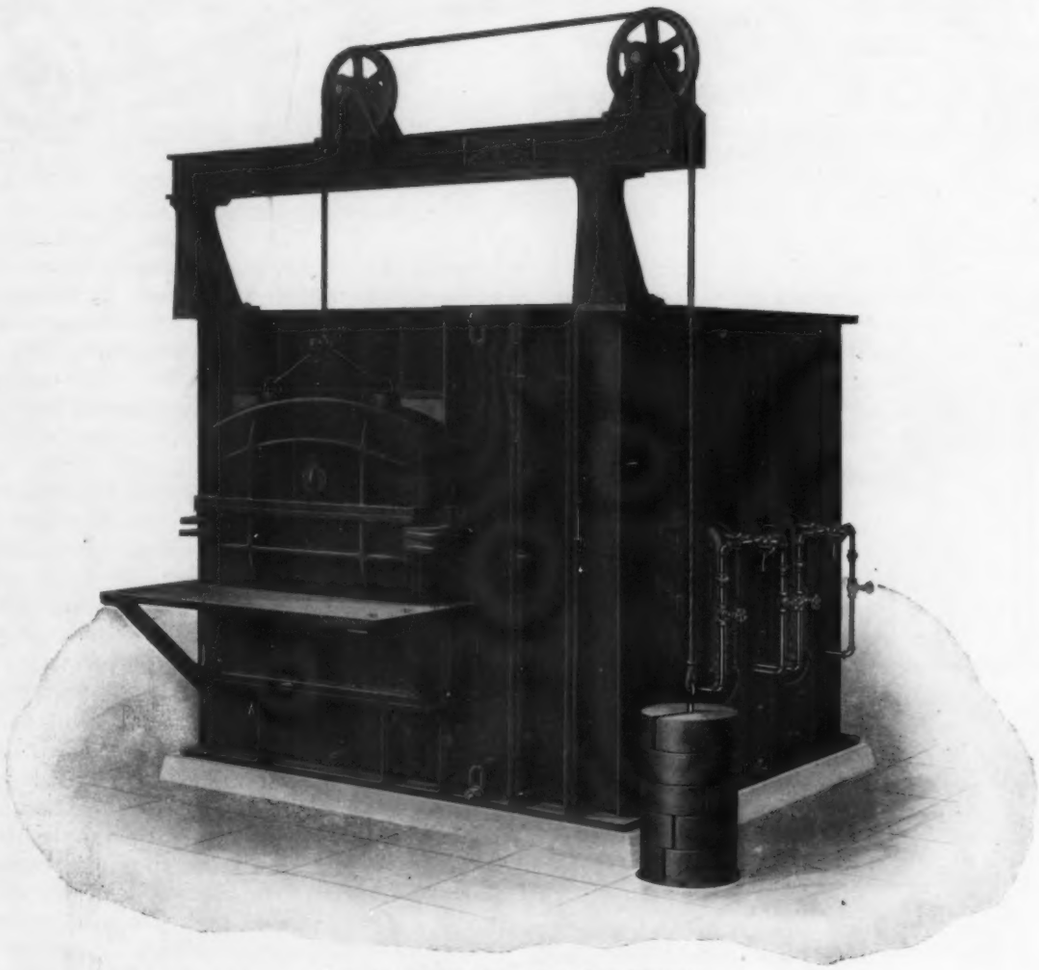

Fig. 74. Large Heat Treating Furnace.

In the main flue is located the air blast pre-heater pipe; the air passing through this pipe is pre-heated to almost the flue temperature. This effects an economy of fuel, for it lowers the temperature of the gases leaving the furnace, and returns to the furnace a large amount of heat which would otherwise have been lost. The working openings are covered by heavy fire brick doors, encased in cast iron frames flanged and ribbed to prevent warping and cracking. These doors are raised and lowered by a direct counter-balancing arrangement, operating on roller bearings, and when lowered are held firmly against the furnace front by door checks. An opening with a cover is provided in the door for a peep-hole. This furnace is properly designed for all classes of heat treating, as it amounts to a semi-muffle furnace. It gives an even heat throughout the chamber, without any danger from oxidation. Suitable pyrometer holes are provided in the walls and arch. No stack is required, and either oil or coal may be burned.

Some plants making merchant bar iron from scrap, use a furnace in which the waste heat is utilized by the installation of a boiler at the end of the furnace. Data secured at one plant using this arrangement show the consumption of oil per ton of iron to be 47 gal. The waste heat secured from the two furnaces was sufficient to furnish the necessary steam for operating the engines driving the rolls, pumping water and generating the electricity and steam used throughout the plant.

The report below was received from a rolling mill in which fuel oil has been used for many years. The

manager states that the quality of iron produced from the scrap material is much better with oil than with coal as a fuel. When running through the rolls, the percentage of weight lost is much lower, as the metal is better able to withstand the compression, vibratory and torsional stresses of the rollers. The same size of furnace with coal fuel would only handle from 30 to 32 tons of material daily; and the expense of upkeep is about 35 per cent less than with coal. Various atomizing agents have been tried, including steam, high pressure air, and steam and low pressure air combined; but it has been found that much better results are obtained from low pressure air.

Report on Furnace at Rolling Mill.

Capacity of furnace	40 tons
Type of burner	Low pressure air
Pressure of air	10 ounces
Pressure of oil	20 lbs.
Temperature of oil	110° F.
Time required to heat furnace	1 hour
Oil required to heat furnace	40 gals.
Time required to heat one ton of metal	36 minutes
Oil required to heat one ton of metal	35 2-10 gals.
Oil consumed per 24 hours	1,408 gals.
Metal treated in 24 hours	40 tons
Heat units of oil	18,500 B.t.u.

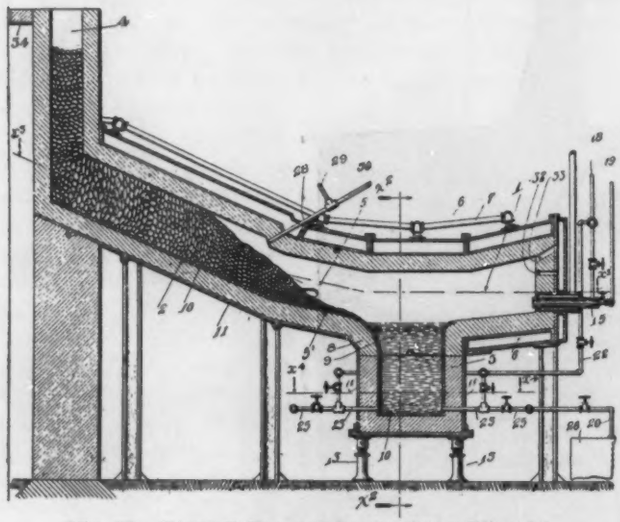

Fig. 75. Riverall Furnace for Smelting With Oil.

The following formula may be used to determine the maximum available horsepower that may be secured from the waste furnace gases:

$$\text{H.P.} = \frac{W\,(T - t) \times S + 777.5}{1{,}980{,}000}$$

where W = the weight of gases passing per hour, in pounds

T = temperature of gases entering the heating surface.

t = temperature of gases entering the heating surface.

S = specific heat in gases.

Blast Furnaces.

As explained in a previous installment, it is difficult to use oil as a fuel for blast furnaces. Many engineers have attempted to design a blast furnace in which this cheap fuel could be used, one of the first of these experiments to come to the attention of the writer was conducted at Los Angeles by Mr. E. Riverall. Fig. 75 shows sectional views of his furnace for smelting ore with oil.

The ore and flux are introduced through a charging door directly under the stack, and pass down the inclined bottom of the furnace, the molten metal and slag being collected in the crucible at the lower end, from which they can be capped off. The oil is introduced with steam, through a number of jets placed on the top of the furnace as shown. The furnace described is 40 ft. in length and 2 ft. in the clear, inside. The inventor points out that during the past decade numerous attempts have been made to accomplish this

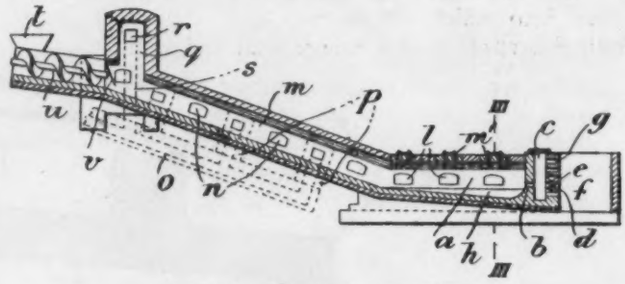

Fig. 76. Buchholtz Furnace.

process. It is true, pig iron has been secured by experimenters with oil as fuel, but in no case has more than 150 lb. of the charge been reduced at one time, and even then coke or charcoal had to be introduced to the extent of 10 per cent, or thereabouts, in order to bring about the necessary chemical reaction. Heretofore all effort to produce this important material in commercial quantities, using only crude oil as fuel, have failed, because of the apparently insurmountable difficulties in the way. Chief among these was the getting rid of oxygen in the iron ores, and the application of the heat directly upon the entire body of the ore to be reduced. This process is both simple and inexpensive, being less complicated than the cupola or upright smelter, and requiring none of the cumbersome machinery incidental to the hoisting of both ore and fuel to the top of the flue.

On August 19, 1902, Mr. Riverall made a trial run in his 50 ton experimental smelter at Tropico, Los Angeles County, California, in the presence of Prof. Joseph Kirkham, general manager of the Pacific Art Tile Works, and several other responsible persons. For more than half an hour molten metal ran out in a steady stream, and then the furnace was shut down, as its success had been demonstrated to the satisfaction of all concerned. The resultant slag consisted of 45 per cent silica and alumina, 50 per cent of lime, and 5 per cent of iron and other elements. The chief claim urged by the inventor in favor of his smelter is its economy.

A patent was recently granted to Mr. Ernest Buchholtz of Harrow, England, for a furnace for "roasting, smelting, or otherwise treating ores." Fig. 76 illustrates this furnace, and by referring to Fig. 75 it will be noticed that the principle of treating the ores is practically the same as in Mr. Riverall's furnace. An air blast is not used in either, and they cannot, therefore be strictly termed blast furnaces.

[To be continued.]

INSIDE WIRING METHODS

By JOHN CARRELL

FILING SYSTEMS.

To do much work in little time without appearing to be very busy is characteristic of some contractors. They maintain a calm, pleasant mental attitude and put in very little overtime, yet their work is always up to the minute; but the things they work with are kept in perfect order; they make few unnecessary or false moves and are able to distinguish the essential from the unimportant. Of great aid to these contractors are the simple office methods employed as an auxiliary to the principal accounting system.

Two very simple methods of filing estimates are used. In the first method the estimate is filed alphabetically according to name, the folder being marked with the name of the architect or party to whom the bid is sent, the street location and date. A copy of the bid is filed, also according to name, but in a different drawer. If the contract is let to another firm the bid is termed "dead," the copy is removed from the bid file and placed in the estimate folder, thus keeping the bid file free of dead material.

In the second method the estimates and bids are given corresponding numbers; but the estimates are filed in numerical succession and the bids according to names of architects. When contracts are let to other firms the respective bids are removed from the live bid file and placed in a dead bid file. These bid files serve as indexes for the estimate file.

With either system: if a contract or order is secured the successful bid and estimate are placed in the same folder and into the contract file. In this file are placed all correspondence, material and labor cost sheets and kindred data relative to the job. Bellows folders having two or more compartments are largely used for this purpose unless the jobs are of small size.

When the work is finished and collections made the data will be valuable in case of repair work or alterations on the same job, and will be reliable cost data with which to compare installations of similar class and type of construction. The folder is removed from the contract file and replaced with the estimates in accordance with the system used; but in a small card index devoted to the classification of installations a description of the job is recorded for the benefit of the estimator.

Thus far, with the exception of the last named classification index, there has been no clerical work involved except the labeling of the folders, and the placing of the data out of the way. The second system seems to be the best because all estimates of more recent data are grouped and, although two bid files are essential, they comprise a more compact and ready reference than does the major file of the first system. Both systems take into consideration the possibility of value in dead estimates, such as a job becoming tied up and new bids called for or for purposes of appraising value in case of fire, etc.

For use in the contract file, folders of the bellows type having three compartments are preferable; one compartment for correspondence, the estimate and statement of totals, one for material and miscellaneous expense and one for labor cost data. The statement of totals referred to is a master sheet which the accountant prepares weekly and shows the present total installation cost with separate entries for labor and material.

The use of a master sheet showing progressive installation costs is invaluable. Before replacing it in the file it is given the estimator and superintendent (should be estimator-superintendent) to compare the estimated cost with actual costs according to the progress of the job. This keeps the men responsible for the financial results of the job continually watching all leaks, including those at the spigot.

Sometimes the estimator will desire to know details concerning the quantity of material which goes into a job. This is accomplished by making out material sheets in triplicate, using two carbon copies; the original going with the delivery, one copy going to the stock clerk's file and one to the bookkeeper. When the signed original is returned, the bookkeeper retains it for the job file and forwards the carbon copy to the estimator with the master sheet.

Triplicate order books are useful, especially when purchasing material from a supply house for use on time and material, or percentage jobs. The original goes to the supply house, one copy is retained with which to check the goods as entered on the seller's invoice and one is placed in the job file. The advantage lies in the check against billing out a job, probably receiving a payment and then having a not included bill come drifting in from the supply house.

A department of a contractor's filing system is the plan rack in which plans with specifications enclosed are stored for future reference. No ready made device is manufactured for the purpose but a closet found on the premises or specially built, is subdivided as far as convenient and made to serve. Hooks, one for each letter in the alphabet, are placed at intervals along the tops of the shelves. Tags on which are marked the name and location of the job are attached to the plans by means of strings so that the strings may be laid over the proper hooks to form the index.

Rights of way over the public domain cannot be acquired by corporations for use in generating power under the original provisions of section 2239 of the Revised Statutes of the United States, but can be granted under the later acts of the Secretary of the Interior only. (U. S. v. Utah Power & Lt. Co. 209 Fed., Nov., 1913.) Where vested water rights for mining purposes have accrued under section 2339, and such rights are recognized and acknowledged by local customs, laws, and decisions of the courts, such rights are protected by the statute and can not be forfeited or otherwise lost by any acts of the government officers. A power company obtaining a right of way for a pipe line to conduct water to its plant and mine for mining purposes will be protected in its right to the continued use of such right of way and pipe line where the land is subsequently incorporated in a forest reserve. (U. S. v. Utah Power & Light Co., 208 Fed., March, 1913.)

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E. B. STRONG, President.

Sworn to and subscribed before me this 24th day of September, 1914.
(Seal.) CHARLES EDELMAN,
Notary Public in and for the City and County of San Francisco, State of California.
(My commission expires April 7, 1918.)

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The High Voltage Potentiometer

In this pragmatic age the average man is apt to question and even to scoff at the value of theoretical investigation. Unless an immediate use can be found for a result it is condemned as a waste of time. To these doubters the classic experiments of Professor Ryan form a fitting rebuke. Undertaken in the spirit of research they are finding a practical application in the design of high voltage insulators.

It was Lord Kelvin who said "No scientific statement is understood until it is measured." For the measurement of differences of potential in insulator porcelain there was no satisfactory means until Professor Ryan developed the high voltage potentiometer.

In operation, the potentiometer is much like a chemical balance where an unknown weight is determined by counterpoising it against a number of smaller known weights. In the potentiometer, voltages are measured instead of weights, being determined by the method of subtraction balancing. From such information it is possible to find faults in insulator design and to determine the form and thickness of porcelain which will give the best results.

To those interested in insulators and insulator troubles Professor Ryan's article elsewhere in this issue should be of great value. And to everyone it should bring a greater tolerance for the scientific investigator if for no other reason than that the theory of today is the practice of tomorrow.

Grading Electrical Supplies

The time has come for setting new standards for electrical supplies. The present standard, the Underwriters' Code, is not specific enough as to quality. It has served its purpose admirably in the past, but there is now need for a new grading of material corresponding to improvements which have been made in manufacturing.

The code divides electrical supplies into two classes—those which are safe as to fire hazard and those which are not. It separates the sheep from the goats, the approved from the unapproved.

Now that this first segregation has been accomplished it is necessary to classify the approved supplies according to the quality of material and workmanship. The consumer now has no authoritative differentiation between goods that just pass the Underwriters' standard and those which have a large margin of safety. There are different grades of switches, sockets and wire just as there are different grades of prices. The consumer should be informed so that he will know that he is buying Class C equipment. This need in no way reflect upon Class C equipment which may be as well adapted to his purpose as Class A equipment.

The recently perfected organization of Associated Manufacturers of Electric Supplies might well take this suggestion under consideration. They could agree on certain specifications as to labor and material entering each grade of their product and then the distinction could be drawn as to the particular specification with which the grade might comply.

The success of this plan would be dependent upon educating the architect, contractor and owner as to

the quality of the material being purchased. Just as the consumer is familiar with the fact that different grades of lumber are available for building construction, so should he be taught that there are different grades of electrical supplies.

Opportunities for Electrical Goods in China

The present international war has brought a seeming commercial apathy and industrial uncertainty in many quarters. That such a condition of affairs should exist in the countries actually at war is not at all surprising. But in the countries at peace it is wholly unjustifiable. Especially is this true in the United States where agricultural resources and industrial development have in recent years created untold stores of wealth. But above all, that portion of our country situated west of the Rocky mountains should during these times, while deeply sympathizing with the misfortunes caused by the reckless slaughter of human life now in progress, be keenly alert to the just reward for peaceful endeavor soon to be theirs.

It was early recognized by proponents of the Panama Canal that the Pacific Coast cities and the territory tributary thereto would profit by the completion of this project more than any other district in the world. That the congress of the United States designated a western location for the official celebration of the completion of this stupendous achievement fully proves this fact to be generally admitted throughout the nation.

During the past year another factor for assured early Western commercial supremacy has arisen that a year ago no one in his fondest dreams ever realized. While a world scourge is now daily smashing to pieces great industrial cities and hurling to ruin much of human progress of a thousand years' standing, we of the West, though deploring its existence, yet realize that new opportunities for trade and industrial development thus become ours by birthright.

The Pacific isles, the interior of China and the ever growing importance of the South American republics lining the Carribean and the Pacific now offer unhampered opportunities for commercial aggrandizement never before presented in the annals of the West.

It is to the credit of Japan and her progressive citizenship that that nation is already fully alive to the new and promising outlet for national development that has now become hers. Recent consular reports set forth the invasion of Hong Kong by electrical goods manufactured in the Japanese Kingdom.

The nature of the trade is indicated by the fact that one company imports filaments for incandescent lamps from the United States and manufactures the lamps in Japan. These lamps lack the life and the efficiency of the American or European lamp competing with them, but they attract a considerable trade and supplant, for the time being at least, the better grade of lamps manufactured in Europe or the United States. This is only an instance of trade conditions for the same situation is to be found in imports of insulated wire, fuses, porcelain insulators, globes and similar accessories.

The American flag has been much of a stranger in Oriental ports. American electrical apparatus and machinery have too long held aloof from foreign competition.

A devastating war may be upon us, but in spite of the thousands upon thousands—yes even millions—that may be annihilated the world must and will move onward in its majestic progress. The eight hundred millions living in countries still at peace must be fed, must be clothed and withal much that goes toward human comfort and advancement must be theirs.

Public Policy

As an example of what may be accomplished by any organization of electrical men and as a suggestion for public utilities desirous of creating better relations with the public, the work being undertaken by the public policy committee of the Electrical Development and Jovian League of San Francisco is of interest. The league had been instrumental in bringing together the electrical men of the city, but the apparent lack of a common object toward which they might work prevented them from co-operating to the fullest possible extent.

As each member is directly or indirectly dependent upon the prosperity of the electric utilities, street railway, telephone or central station, it is to his interest to promote the welfare of the utility. So it has been proposed that each member of the league constitute himself a committee of one to improve public relations. In order that this may be possible, the members are being instructed in the several problems which confront the various branches of the industry, and are thus prepared to answer criticism. Causes for complaint are being investigated and remedies suggested to the company affected. Education, like charity, begins at home. Later is it planned to broaden the scope of the committee's activities so that the general public may also be educated. Speakers from the league will be available to address other organizations on the subject of better public relations and authentic information regarding service changes, rates, accidents, financial reports and other matters of public interest will be supplied to the newspapers, making this committee a clearing-house for such information.

Attention is not being devoted solely to the problems of the utility corporation, for the committee is giving due consideration to such matters as the sale of lamps and appliances by central stations, lower rates for heating appliances and standardization of product. By thus setting definite objects to be accomplished the league is taking its rightful place in the industry and binding the several interests more closely together.

The league is characterized by unity of idea and unity of action. The jobber realizes that it is his job to create better public relations, the manufacturer is making an improved public sentiment, the contractor is building better public relations, and as a base upon which all other efforts may be predicated the utilities are striving to eliminate cause for complaint against their service. With such singleness of purpose it should be possible for all the different interests to prosper, just as a thousand persons of diverse minds surrounding a conical hill might all reach the summit blindfolded by following the line of greatest resistance.

PERSONALS

F. L. Crooks, an electrical engineer of Williamsport, Penn., is at San Francisco.

F. H. Leggett, Pacific Coast manager of the Western Electric Co., is at Seattle.

E. Jansen, electrical engineer of Eureka, Cal., was a recent visitor at San Francisco.

F. E. Boston, electrical engineer of Gasdines, Maine, is a recent visitor at San Francisco.

Dr. W. G. Wylie, vice-president Southern Power Company, New York, is a recent visitor to California.

A. F. Flanagan, an electrical contractor of Stockton, Cal., spent several days recently at San Francisco.

A. K. Ehrenpfort, engineer of the Union Lumber Co., at Fort Bragg, Cal., spent the week at San Francisco.

J. Beane of the Nevada Valleys Power Co., Lovelock, Nev., spent several days during the week at San Francisco.

H. H. Medcraft of the Anderson Electric Co., Anderson, Cal., spent a few days during the week at San Francisco.

W. Hild of the Electric and Machine Equipment Co., Stockton, Cal., spent a few days at San Francisco during the week.

Chas. W. Baker, engineer with Hunt Mirk & Co., San Francisco, is making a business trip through southern California.

A. Terkel, proprietor of the Reedley Electric Works, Reedley, Cal., spent the latter part of the week at San Francisco.

A. Emory Wishon, assistant manager of the San Joaquin Light & Power Corporation, was at San Francisco from Fresno during the past week.

M. K. Pike, distributing department manager for the Northern Electric Co., Montreal, spent several days during the week at San Francisco.

H. B. Vanzwoll, sales manager of the Sunbeam Division of the National Lamp Works, is visiting the Pacific Coast, now being at San Francisco.

H. B. Squires of the H. B. Squires Co., San Francisco, is expected back the first of the week from an extended business trip through the East.

A. B. Strange, assistant to the president of the Gold Core Heating & Lighting Company of New York City is visiting the Exposition at San Francisco.

A. R. Gould, general manager Maine & New Brunswick Electric Power Company, Presque Isle, Maine, is at San Francisco, visiting the Exposition.

L. M. Klauber, superintendent of electrical distribution for the San Diego Consolidated Gas & Electric Company, has returned to San Diego after a brief visit to San Francisco.

S. M. Graff, owner and manager of the Seward Light and Power Company of Seward, Alaska, spent several days in Seattle recently en route to the Exposition at San Francisco.

D. E. Harris of the sales force of the Pacific States Electric Co., San Francisco, left the first of the week for an extended business trip through the northern part of California.

C. C. Hillis, manager of the Electric Appliance Co., San Francisco, left for the East during the week, where he expects to remain for some time on account of the illness of his father.

H. F. Yost of the Electric Railway and Manufacturers Supply Co. returned during the week after an extended trip through Nevada and left for a business trip through northern California.

Frank Ford has been appointed electrical engineer for the Pittsburg Electric Construction Company of Williams, Ariz., and will have charge of the company's construction work at Clarksdale.

S. E. Hodge of the industrial power and mining department of the Seattle branch of the Westinghouse Electric and Manufacturing Company has returned from a two weeks' trip throughout southeastern Alaska.

J. Ludwig Hansen of the Siam Electricity Co., Bangkok, Siam, who is making a business visit to this country, spent several days of the past week at San Francisco, visiting the Exposition and the electrical houses generally.

E. M. Schlessinger, factory superintendent for the Electric Railway and Manufacturers Supply Co., will shortly leave this firm and the electrical business to associate himself with the Giant Valve and Manufacturing Co., San Francisco.

E. A. Wilcox has resigned as commercial agent for the Great Shoshone & Twin Falls Water Power Company at Twin Falls, Idaho, to accept a position in the commercial department of the Great Western Power Company at San Francisco.

W. C. Wurfell, formerly connected with the Westinghouse Electric & Manufacturing Company organization at Salt Lake City, has succeeded **Munson Burton**, resigned, as Pacific Coast manager for the Westinghouse Lamp Company with headquarters at San Francisco.

A. A. Miller of the railway and light department of the Seattle branch of the Westinghouse Electric and Manufacturing Company will address the next meeting of the university branch of the A. I. E. E. at the University of Washington, on the subject of "The Choice of Engineering as a Profession."

MEETING NOTICES.

Portland Electric Vehicle Association.

Every Monday at noon a number of electrical vehicle men of Portland meet at lunch. At present this organization has not affiliated with the Electrical Vehicle Association of America, but will probably do so in the near future. Mr. W. Spaulding, who is a member of the membership committee of the E. V. A. A. is the moving spirit. Mr. Spaulding represents the Milburn light electrics and the Walker electric trucks, with offices 110 Thirteenth street, Portland, Oregon.

Portland Jovian League.

Robert Skeen, proprietor of the Skeen Electric Company, was chairman of the day at the luncheon held in the Crystal Dining Room of the Benson Hotel, Portland, Oregon. No special speaker was present, the members of the club talked over in an informal way methods to better broaden its work. The musical program was given by John Faulkner and C. C. Davies. The Oregon Society of Engineers has arranged to hold its luncheons each week jointly with the Jovian League. Mr. F. W. Hild, general manager of the Portland Railway, Light & Power Company will be the speaker of the day on April 9th, his subject will be "The Needs of the Electrical Industry and Allied Industries in Portland." Mr. Henry Schade was appointed chairman of a committee to plan programs for future meetings.

Portland A. I. E. E. and N. E. L. A. Sections.

The regular joint meeting of the Portland sections of the A. I. E. E. and the N. E. L. A. were held in the Hawthorne Building under the direction of the Portland Railway, Light & Power Company Tuesday evening, March 30th. Mr. E. A. West, efficiency engineer, read a lecture prepared by Mr. Douglas of the N. E. L. A., on "Safety First," which was illustrated with lantern slides and moving pictures; also Mr. J. W. Stevens, the fire marshal of Portland, spoke on the question of "Fire Precaution" and Chief Dowell of the fire department gave a few remarks on his personal experiences regarding this subject. The employes of the Portland Rail way, Light & Power Company have voluntarily organized a brass band and this rendered several fine selections during garding this subject. The employes of the Portland Rail-

way, Light & Power Company, acted as chairman of the evening. The attendance was several hundred as the meeting was thrown open to the public.

Electrical Development and Jovian League.

The meeting on March 31st at Bergez Franks, San Francisco, was intended as an example of what the newly appointed public policy committee intends to do in the way of educating the league members about better public relations between the public service corporations and the public. As chairman of the day, Mr. Miles Steel, after providing an enjoyable musical novelty in a band of Hawaiian singers, introduced Mr. A. H. Babcock, electrical engineer for the Southern Pacific Company, who spoke on "Relations Between the Public and the Public Service Corporation," as exemplified by the Alameda County rate case. In half an hour's time Mr. Babcock condensed the great mass of information which had been presented before the California Railroad Commission with regard to fares charged by the Southern Pacific Company on its electric lines. He showed conclusively that the accounting charges against these lines are just and in proportion to the number of passengers handled, that they are being operated at a loss. This is necessary because of competition and in order to anticipate future requirements. He emphasized the necessity of bringing about a better attitude on the part of the public toward the corporations.

The Jovian Electrical League of Southern California.

The well attended luncheon of the League held at Christopher's, Los Angeles, on March 31st, was ably presided over by Roger Ray Thomas. A good musical program was provided by a young Russian singer, accompanied by Dick Alter. The speaker of the day was B. L. Graves, manager of the Los Angeles branch of the Ford Motor Car Company, who, while admitting that everybody is waiting for the "last" Ford story, told some new ones himself, all of which, most naturally, were at the expense of "automobiles." Mr. Graves told his hearers about Ford's early experiments and his midnight experiences on the streets of Detroit with his first model. He referred to Ford as a practical dreamer, who makes his dreams come true. One who takes a long time to make up his mind but when he does he will bet his life on his decision. Take his magneto, for example. It was declared to be against all mechanical laws and good judgment. Still Ford spent $10,000 experimenting on it and won out, over a half a million being in use at present. He believed in lightness of construction and again he proved that his judgment was good. He spoke of Mr. Ford's wonderful personal magnetism which makes his men work not only for their wages, but because they love Henry Ford. His profit-sharing plan was explained, which means the distribution of ten million dollars annually among his employes.

Mr. Graves was followed with a brief talk by Warren Hilton, president of the Society of Applied Psychology, who gave much wholesome advice on business efficiency. He quoted Hugh Chalmers' list of five essential M's in business, namely: Money, material, merchandise, machinery, and men.

NOTICE TO PACIFIC COAST A. I. E. E. MEMBERS.

Some little confusion has arisen among Pacific Coast members of the American Institute of Engineers over the action of the directors of the Institute in not including Prof. Harris J. Ryan's name among its nominees for vice-president, whereas he was second in the number of votes accorded in the general proposal list. The circular of notification is at fault in not explaining that Professor Ryan has been appointed honorary vice-president, as has been previously announced in these columns. This appointment makes further action by Pacific Coast members unnecessary, as proper recognition has thus been accorded him and the Pacific Coast. With reference to this honor which has been accorded him Prof. Ryan states, "I realize that we have been accorded a splendid opportunity to co-operate with the administration of the Institute in the conduct of its affairs during the exposition year."

AMERICAN ELECTRIC RAILWAY ASSOCIATION CONVENTION.

More than five thousand members and delegates, including many electric traffic experts and engineers of nation-wide prominence, will attend the annual convention of the American Electric Railway Association, which will be held at the Exposition Civic Auditorium, San Francisco, October 4-8, inclusive. A feature of the proceedings will be the outlining of plans for the promotion of better relations between the electric carriers and the public.

The American Electric Railway Manufacturers' Association, an allied organization, will hold its convention in conjunction with the first-named association, which consists of the parent organization and four affiliated organizations composed of accountants, engineers and transportation and traffic experts.

H. G. McConnaughy, director of transportation, has just left San Francisco after making arrangements for the convention. He has arranged to send out three special trains from New York and one from Chicago, and it is probable that there will be additions to this number, as the usual attendance is more than five thousand. The association represents 36,000 of the 41,000 miles of electric railways in the United States and its members receive more than $500,000,000 of the $533,000,000 yearly receipts from the electric lines. Their employes number 270,000 of the 300,000 engaged in electric railway service. It may be interesting to note that during the last year these companies carried more than 12,000,000,000 passengers, which is more than seven times the population of the world.

The attendance from the Atlantic Coast and Eastern States to the convention will be unusually large this year, while the companies located on the Pacific Coast will be well represented. Matters of general interest will be taken up, with special attention to the promotion of a more cordial feeling between the electric carriers and the public.

TRADE NOTES.

C. P. Scott has the electrical contract for the Western Supply Company, 61 Front street, Portland.

B. E. Davis has the electrical contract for the Coast Brush Manufacturing Company's new plant at 3 Union avenue, Portland.

The exploitation and publicity work of the Mazda Bureau will be extended to Portland and the Northwest country on the 15th of April.

A. E. Meserve of Portland, is installing the electrical equipment on the ground floor, at 275 Alder street, which belongs to the Wilson estate.

Ne Page, McKenny Company have the electrical contract for the new Coin Machine Mfg. Company's plant to be built in the Holgate addition, Portland.

E. L. Knight & Company have the electrical contract for the Tunnio-Cress & Company's new warehouse located at Harrison and Water streets, Portland.

The Light House, Portland, has the Electrical Contract for the remodeling of the electric system in the H. Weinhard Estate Building, 68 Fifth street, Portland.

Monday has been set aside to open up the Busch-Sulzer Bros. Diesel Engine Company Diesel engine in the center of the Palace of Machinery, to enable engineers to make an inspection of the enclosed working parts which can not be seen while the engine is in operation.

CALIFORNIA ASSOCIATION OF ELECTRICAL INSPECTORS

Section of N. A. E. I.

C. W. Mitchell, President. Arthur Kempston.
Wm. G. Pennycook, Vice-Pres. B. C. Hill, Executive Comm.
John W. Carrell, Secretary-Treasurer, 814 Scott, San Francisco.

The purpose of this organization is to standardize the common practice in electrical construction with the National Code as the general standard.

Questions pertaining to electrical construction will be answered in these columns, but only from the point of view of the Code. This is a voluntary organization and the answers published under this heading must not be construed as authoritative, or binding. No attempt will be made to correllate the answer from the several Inspection Districts, as an occasional difference of opinion will tend to induce further study on subjects. All questions will be passed upon by an executive committee.

Address all communications to the secretary.

The April meeting of the C. A. E. I. will be held April 10th, at 2:30 p.m. in the Board room, Fire Underwriters of the Pacific, room No. 914 Merchants' Exchange Building, San Francisco. The business of the meeting will be an election of officers for the ensuing year. In addition an annotated copy of the Code Committee Bulletin giving the results of the March meeting of Electrical Committee, National Fire Protection Association, will be read. The association expects every member to be present at this meeting.

Opportunities to interchange ideas regarding efficient working methods should be a fascinating attraction to members of a profession; but unfortunately such is not always the case. As a rule, a common enemy, an impending calamity or a bond of sympathy is required to unite men to any purpose. Those who are willing to occasionally assemble and discuss improved methods of dealing with routine work or to anticipate the effect of new discoveries or inventions on their business are usually efficient to begin with, and maintain or increase their efficiency by means of mutual discussion and besides, such men are often able to dig a few things out of the dark for themselves. To stick at home, to persistently avoid meeting with your co-workers, to be satisfied with the degree of progress to which you have been forced, is to be like a stone on the ground waiting to be kicked over; and when a stone is upturned there are often a number of wiggling, creeping, crawling things collected under it. True, a rolling stone gathers no moss; but who on this side of his Satanic majesty's regions wants to be a moss-back?

Inspection has often been said to be fifty per cent moral effect. The statement may be true, but, if so, the other fifty per cent should consist entirely of efficiency. Besides a careful training in the work a constant review of the elements of the knowledge which comprise the business is mandatory. Advances in the manufacture of translating devices, new material or fitting and, in consequence, new methods of workmanship are ever before us. There is no way more sure, to keep abreast with the times, than to compare and check your experience and ideas with men of the same mind, working in the same field.

The 1915 edition of the National Electrical Code will contain many important changes. An opportunity is now presented to men engaged in electrical inspection service to become familiar with the new code before the date of issue. All electrical inspectors whether members of the C. A. E. I. or not are invited to attend our meetings.

NEWS OF CALIFORNIA RAILROAD COMMISSION.

The commission has issued a supplemental order granting the Holton Power Company an extension of time to and including March 24, 1916, within which to issue $200,000 face value of its six per cent first and refunding mortgage gold bonds.

The commission has issued an order granting the Marin County Electric Railways an extension of time to and including July 1, 1915, within which to sell stock for the construction of a street railway system in Mill Valley.

The commission has issued a report covering the financial activities of the public utilities of the state during the year 1914. The report shows that the public utilities of all classes were authorized to issue securities during the year 1914 to the total sum of $226,000,000. For the entire period of the commission's jurisdiction over securities, from March 23, 1912, to December 31, 1914, the public utilities of the state were authorized to issue securities amounting to approximately $400,000,000. The securities authorized for the year 1914 exceed those authorized for the entire year of 1913 and the eight months of 1912. While no accurate figures are available for the period prior to 1912, it is probable that the security issues of 1914 of public utility corporations were the greatest in the history of the State of California. While all of the securities authorized were not issued, it may be estimated that approximately 75 per cent of those authorized either have been already issued or are to be issued. The report also shows that during the year 1914 the commission denied or dismissed applications to issue securities amounting to approximately $17,000,000. The record of new development shows that work was carried forward during 1914 on 700 miles of projected new railway enterprises. In addition, the power companies carried forward projects embracing approximately 100,000 additional horsepower for the state.

The commission has issued an order authorizing the Santa Maria Gas & Power Company to issue $25,000 of first mortgage six per cent bonds.

The Southern Counties Gas Company of California has filed an application with the commission, requesting authority to borrow $40,600 from the Central Trust Company of Illinois, and to secure the same by a pledge of $60,000 of its three year gold notes.

The Pacific Light & Power Corporation of Los Angeles has filed an application with the commission, requesting authority to enter into a collateral trust agreement, providing for the extension of its collateral trust bonds of the face value of $2,338,000 from July 1, 1915, to July 1, 1917.

The Los Angeles Railway Corporation has filed an application with the commission requesting authority to sell $250,000 of its first and refunding mortgage gold bonds for the purpose of refunding $250,000 of first mortgage six per cent bonds of the Los Angeles Traction Company falling due on May 1, 1915.

The commission has issued an order authorizing the Coast Valleys Gas & Electric Company, which operates a water, gas and electric utility business in Salinas, Monterey, Pacific Grove, Kings City and other parts of Monterey county, to issue $10,000 of bonds.

The Southwestern Home Telephone Company of Redlands has filed an application with the commission, requesting authority to renew promissory notes totalling $14,500.

NEWS OF IDAHO PUBLIC SERVICE COMMISSION.

Governor Alexander has called upon Attorney General Peterson and the Public Utilities Commission to investigate the alleged consolidation of rival Southern Idaho hydroelectric power companies into the National Securities Company, a subsidiary of the Electric Bond & Share Company of New York, which is to become the holding company of all those in this state. The consolidation includes the Idaho-Oregon Light & Power Company, the Idaho Railway, Light & Power Company and the Idaho Power & Light Company, rivals in the Western Idaho field; the Great Shoshone and Twin Falls Waterpower Company in the Twin Falls field and the Southern Idaho Waterpower Company in the Pocatello field. Governor Alexander declares that "holding companies are detrimental to the best interests of the state."

NEWS NOTES

INCORPORATIONS.

FIFE, MONT.—The Fife Range Farmers' Telephone Company has been incorporated here.

LEWIS, MONT.—The Big Bottom Telephone Company, Inc., $1250. John C. Snyder, Albert L. Gilleland, W. W. Stephens, H. B. Blankenship.

PARLIER, CAL.—The Riverbed Gas & Water Company is a newly organized corporation that proposes to supply Parlier, Reedley, Sanger and Kingsburg with gas and water. The incorporators are the stockholders of the Parlier winery, who have had the project in view for several months. It is announced here that the complete outlay of the plant would be between $30,000 and $40,000 and that it was expected to begin work inside of 30 days. Bids are now being received. An application for a special permit has been filed with the railroad commission. The promotors of the project have also applied for a franchise from the town of Kingsburg.

ILLUMINATION.

SOUTH BEND, WASH.—The Northwest Electric & Water Works Company has asked for a 25 year extension to its franchise.

WALLACE, IDAHO.—John H. Wourms and associates have filed an application for a gas franchise in Wallace, stating they are ready to begin work at once.

PRAIRIE CITY, ORE.—The Prairie Power Company is considering moving its power plant, which is three miles out of town, down by their flour mill in the town.

SAN JOSE, CAL.—Among the first improvement work to be taken up by property owners on West Santa Clara street will be the installation of electroliers along both sides of the street.

PE ELL, WASH.—The Lewis County Light & Power Company by C. Oliver Smith, has asked the council for an ordinance granting a franchise to operate electric power and light lines in the city.

TEHACHAPI, CAL.—A resolution was adopted declaring that public necessity and convenience demands the construction of an electric light and power system, the estimated cost of the same being $8000.

CATHLAMET, WASH.—C. H. Reeves proposes to petition the city council for a 10 year franchise for an electric light plant with the privilege of the city buying the system at the expiration of the franchise.

HEALDSBURG, CAL.—The trustees have authorized Mayor J. A. McMinn to enter into a contract with the General Electric Company for the purchase of all electric meters used by the city for one year from date.

SEATTLE, WASH.—Bids will be received until April 21 by the Port of Seattle Commission for the installation of a light and power system for a fruit storage building in the East Waterway terminal improvement.

SANTA BARBARA, CAL.—The Santa Barbara Gas & Electric Company is preparing to improve its gas plant, increasing the output to 1,500,000 cubic feet. New gas generators and compressors will be installed.

LOS ANGELES, CAL.—Members of the Long Beach Chamber of Commerce have taken up plans to illuminate Long Beach boulevard. An ornamental lighting system will be installed to extend from Los Angeles to the seaside city.

BAKER CITY, ORE.—Forms for a petition for the extension of the city lighting plant have been filed with City Clerk Cunning. The petition asks for a special election to be held July 14th, to allow the people of Baker to vote on an $80,000 bond issue for the enlargement of the city power plant.

OAKLAND, CAL.—Bids have been opened by the city council for furnishing exterior lighting equipment and interior lighting fixtures for the new city hall and referred to the city attorney and the public buildings committee for further action.

SEATTLE, WASH.—The Gas Service Corporation of America, Leary Building, has let the contract to the Burnett Construction Company for two gas plants, one at Bremerton and the other at Montesano. The first named will cost $100,000 and the latter $50,000. Contract includes laying of mains throughout each city, steel gas tanks and retainers, construction of small buildings, etc., a portion of which will be sublet.

TRANSMISSION.

PASADENA, CAL.—W. A. McNally & Company have been awarded the contract for the conduits on South El Molino, Alpine, Elliott Drive and Pinehurst Drive at $14,876. There were five other bidders.

ALBUQUERQUE, N. M.—State Engineer James A. French has approved the application of A. H. H. Palmer for a power project at Mogollon, Socorra county. Ten second feet are granted to develop 100 h.p. for milling purposes.

TRANSPORTATION.

SAN FRANCISCO, CAL.—The board of public works has called for bids for furnishing and installing underground electrical conductors for the Geary Street Municipal Railway.

REDWOOD CITY, CAL.—An ordinance has been adopted approving the transfer by Edward F. Fitzpatrick to the Redwood City Harbor Company, of a franchise granted him authorizing the construction of a street railway along Chestnut street.

SAN FRANCISCO, CAL.—Mayor Rolph has vetoed the permit given by the supervisors to the United Railroads to run cars on Sutter and Polk streets between the Ferry and the Exposition entrance at Van Ness avenue. Mayor Rolph has vetoed also the authorization given by the supervisors for an exchange of transfers at the beach between the Municipal Railway and jitney busses.

MILES, WASH.—The Big Bend Transit Electric Railroad projected from Spokane along the Spokane River to its junction with the Columbia, has filed with C. O. Upchurch, agent for former Spokane Indian Reservation, maps and plans for a line from Spokane to Miles and has asked for further grants and concessions from the interior department on the reservation and the Fort Spokane military reserve.

WENATCHEE, WASH.—Chief Engineer R. Budd of the Great Northern and Judge F. V. Brown have left for Chelan where they will spend some time on business connected with the development of the water power of Chelan Falls. Nothing definite has been given out by the Great Northern in regard to the development of this water power project, but it has been announced that the railroad company intends to electrify its Wenatchee, Oroville branch and also portions of the main line.

TELEPHONE AND TELEGRAPH.

JUDITH GAP, MONTANA.—Work will start at once on the Ross Fork Telephone Company here. Harvey McLaughlin is president.

ALPHABETICAL INDEX TO ADVERTISERS

The letter and number before each name are used in the classified page opposite

A-1 **American Ever-Ready Works of National Carbon Co.**....
Los Angeles; 755 Folsom Street, San Francisco; Seattle.

B-2 **Benjamin Electric Manufacturing Co.**.....
Rialto Bldg., San Francisco.

B-3 **Blake Signal and Manufacturing Co.**..... 3
680 Howard Street, San Francisco.

B-5 **Bridgeport Brass Co.**..... 4
(See Pierson, Roeding & Co.)

B-6 **Berkeley Electric Cooker Co.**.....
1932 Center Street, Berkeley.

B 7 **Busch-Sulzer Bros.-Diesel Engine Co.**.....
Rialto Bldg., San Francisco.

C-1 **Century Electric Co.**..... 2
614 South Grand Avenue, Los Angeles; 56 Natoma Street, San Francisco; Seattle; Spokane.

C-3 **Crocker-Wheeler Co.**.....
Salt Lake City; First National Bank Bldg., San Francisco; Seattle.

C-4 **Cutler-Hammer Manufacturing Co.**.....
579 Howard Street, San Francisco; Morgan Bldg., Portland, Ore.; San Fernando Bldg., Los Angeles.

D-1 **D. & W. Fuse Co.**.....
Western Electric Co.

D-2 **Dearborn Drug and Chemical Works**..... 4
355 East Second Street, Los Angeles; 301 Front Street, San Francisco.

E-1 **Edison Lamp Works of General Electric Co.**..... 10
Rialto Bldg., San Francisco.

E-2 **Edison Storage Battery Supply Co.**..... 4
441 Golden Gate Avenue, San Francisco.

E-3 **Electric Agencies Co.**.....
247 Minna Street, San Francisco; Central Building, Los Angeles.

E-4 **Electric Storage Battery Co.**.....
Pacific Electric Bldg., Los Angeles; Spalding Bldg., Portland; 118 New Montgomery Street, San Francisco; Colman Bldg., Seattle.

F-1 **Fairbanks, Morse & Co.**.....
Los Angeles; Portland; 651 Mission Street, San Francisco; Seattle; Spokane.

F-2 **Fort Wayne Electric Works of G. E. Co.**.....
Rialto Bldg., San Francisco; Colman Bldg., Seattle.

G-1 **General Electric Co.**..... 10
124 W. Fourth Street, Los Angeles; Worcester Bldg., Portland; Rialto Bldg., San Francisco; Colman Bldg., Seattle; Paulsen Bldg., Spokane.

H-1 **Habirshaw Wire Co.**.....
(See Western Electric Company.)

H-2 **Hemingray Glass Co.**..... 4
330 So. L. A. Street, Los Angeles; 345 Oak Street, Portland; 807 Mission Street, San Francisco.

H-5 **Hunt, Mirk & Co.**.....
141 Second Street, San Francisco.

H-6 **Hubbard & Co.**.....
Rialto Bldg., San Francisco.

I-1 **Indiana Rubber and Insulated Wire Co.**..... 2
Fobes Supply Co., Portland and Seattle.

K-1 **Kellogg Switchboard and Supply Co.**.....
Aronson Bldg., San Francisco.

K-4 **K-P-F Electric Co.**.....
37 Stevenson Street, San Francisco.

L-1 **Leahy Manufacturing Co.**.....
Eighth and Alameda Street, Los Angeles.

L-2 **Locke Insulator Manufacturing Co.**..... 4
(See Pierson, Roeding & Co.)

M-2 **McGlauflin Manufacturing Co.**.....
Sunnyvale, Cal.

M-4 **Morse Chain Co.**.....
Monadnock Bldg., San Francisco.

M-3 **Moore & Co., Charles C.**..... 3
Van Nuys Bldg., Los Angeles; Spalding Bldg., Portland; Kearns Bldg., Salt Lake City; Sheldon Bldg., San Francisco; Mutual Life Bldg., Seattle; Santa Rita Hotel Bldg., Tucson.

N-1 **Nason & Co., R. N.**.....
151 Potrero Avenue, San Francisco.

N-2 **National Conduit & Cable Co., The**.....
Trust and Savings Bldg., Los Angeels; Rialto Bldg., San Francisco.

N-3 **National Lamp Works of G. E. Co.**.....
(All Jobbers.)

N-4 **New York Insulated Wire Co.**.....
629 Howard Street, San Francisco.

O-1 **Okonite Co. (The)** 12
(All Jobbers.)

P-1 **Pacific Electric Manufacturing Co.**.....
80 Tehama Street, San Francisco.

P-2 **Pacific States Electric Co.**..... 2
236-240 So. L. A. Street, Los Angeles; 90 Seventh Street, Portland; 200-210 12th Street, Oakland; 575 Mission Street, San Francisco; 307 First Avenue, So., Seattle.

P-4 **Pelton Water Wheel Co.**..... 4
2219 Harrison Street, San Francisco.

P-5 **Pierson, Roeding & Co.**..... 4
Pacific Electric Bldg., Los Angeles; Spalding Bldg., Portland; Rialto Bldg., San Francisco; Colman Bldg., Seattle.

P-7 **Pittsburgh Piping & Equipment Co.**.....12
Monadnock Bldg., San Francisco.

S-1 **Schaw-Batcher Company, Pipe Works, The**.....
211 J Street, Sacramento; 356 Market Street, San Francisco.

S-3 **Simplex Electric Heating Co.**.....12
612 Howard Street, San Francisco.

S-4 **Southern Pacific Co.**..... 3
Flood Bldg., San Francisco.

S-5 **Sprague Electric Works**..... 3
Rialto Bldg, San Francisco; Colman Bldg.; Seattle; 124 West 4th Street, Los Angeles; Electric Bldg., Portland; Paulsen Bldg., Spokane.

S-6 **Standard Underground Cable Co.**.....
First National Bank Bldg., San Francisco; Hibernian Bldg., Los Angeles; Yeon Bldg., Portland; Central Bldg., Seattle, Wash.

T-1 **Thomas & Co., R.**.....12
(See Western Electric Co.)

W-1 **Wagner Electric Manufacturing Co.**..... 4
Rialto Bldg., San Francisco.

W-2 **Western Electric Co.**.....
8th and Santee Streets, Los Angeles; 507 Sixteenth Street, Oakland; 680 Folsom Street, San Francisco; 907 First Avenue, Seattle; 45 North Fifth Street, Portland, Ore.

W-4 **Westinghouse Electric and Manufacturing Co.**..... 6
50-52 East Broadway, Butte; Van Nuys Bldg., Los Angeles; Couch Bldg., Portland; 212 So. W. Temple, Salt Lake City; 165 Second Street, San Francisco; Second and Cherry Streets, Seattle; Paulsen Bldg., Spokane.

W-5 **Westinghouse Machine Co.**.....
141 Second Street, San Francisco.

W-6 **Westinghouse Lamp Co.**.....
(See Westinghouse Electric and Manufacturing Co.)

W-8 **Western Pipe & Steel Co.**.....
444 Market Street, San Francisco; 1758 North Broadway, Los Angeles.